CLAIMS

We claim:

1. An apparatus for the hydrolysis of protein-containing raw material, the apparatus comprising:

a hydrolysis area that provides hydrolysis of said raw material by reacting a reaction mixture comprising said raw material and at least one enzyme present in said area, wherein the reaction mixture contains both solids and liquid, and wherein upon hydrolysis, said reaction mixture further comprises hydrolysis product;

an inactivation area that receives reaction mixture from the hydrolysis area and substantially inactivates the enzyme present in the reaction mixture; and

a separation area that receives at least a portion of the reaction mixture from the inactivation area and is capable of separating it into two or more components, including at least one substantially liquid component which comprises water-soluble protein.

2. The apparatus of claim 1, wherein the separation area is capable of separating the portion of the reaction mixture received into said at least one substantially liquid component and at least one substantially solid-containing component.

3. The apparatus of claim 1 or 2, wherein any emulsion present in said liquid component is present in an amount at or below a predetermined level.

4. The apparatus of claim 3, wherein the level of emulsion present is at or below about 5 %.

5. The apparatus of claim 3, wherein the level of emulsion present is at or below about 2 %.

6. The apparatus of claim 3, wherein the level of emulsion present is at or below about 1 %.

7. The apparatus of claim 3, wherein the level of emulsion present is at or below about 0.5 %.

8. The apparatus of any of claims 1-7, wherein the separation area comprises a slanted filter screen.

9. The apparatus of any of claims 1-8, further comprising a centrifuge that receives at least a portion of the liquid component, and which separates the portion into at least a first fraction comprising water-soluble protein and at least a second fraction comprising water-insoluble protein.

10. The apparatus of any of claims 1-9, further comprising at least one pump capable of pumping oil present in the reaction mixture away from the reaction mixture, or comprises a decanter for decanting oil present in the reaction mixture, or comprises both.

11. The apparatus of any of claims 1-10, wherein the inactivation area comprises at least one outlet for a solid component of the reaction mixture, and at least one outlet for a liquid component of said reaction mixture, said outlet for said liquid component positioned at a distance from the outlet for the solid component sufficient to avoid or minimize mixing of the solid and liquid components.

12. The apparatus of claim 11, wherein the at least one outlet for the liquid component comprises an outlet for an aqueous fraction comprising water-soluble amino acids, proteins, or peptides and water-insoluble amino acids, proteins, or peptides.

13. The apparatus of any of claims 1-12, wherein the hydrolysis area comprises at least one feeder screw for conveying the reaction mixture through the hydrolysis area.

14. The apparatus of any of claims 1-13, wherein the hydrolysis area comprises a tube-shaped reactor.

15. The apparatus of any of claims 1-14, wherein the inactivation area comprises at least one feeder screw for conveying the reaction mixture through the inactivation area.

16. The apparatus of any of claims 13-15, wherein at least one feeder screw rotates clockwise for a first period of time, and counter-clockwise for a second period of time.

17. The apparatus of any of claims 13-16, wherein at least one feeder screw comprises a thread having a scoop or sheet located at its periphery.

18. The apparatus of any of claims 1-17, wherein the inactivation reactor comprises an outlet for discharging at least a portion of the reaction mixture and an agitator adjacent to the outlet that suspends solid matter in the reaction mixture near the outlet.

19. The apparatus of claim 18, wherein the agitator comprises a screw that rotates in a reverse direction.

20. The apparatus of any of claims 1-19, wherein a pump pumps the reaction mixture out of the inactivation area and toward the separation area, such that emulsification of liquid in the reaction mixture is maintained at or below a predetermined level.

21. The apparatus of any of claims 1-20, further comprising a collection area wherein pieces of protein-containing raw material are collected, and wherein said pieces of protein-containing raw material are provided to the hydrolysis area from said collection area.

22. The apparatus of claim 21, wherein the collection area includes processing equipment that reduces the size of the pieces of raw material collected.

23. The apparatus of any of claims 1-22, wherein the apparatus is capable of hydrolyzing the raw material at a rate of two tons per hour.

24. The apparatus of any of claims 1-23, wherein the apparatus is capable of continuous hydrolysis for at least seventy-two hours.

25. The apparatus of any of claims 1-24, wherein the hydrolysis area, inactivation area, and separation area are capable of operating in a continuous non-batch mode.

26. The apparatus of any of claims 1-25, wherein the apparatus is capable of producing a yield of water-soluble protein from the liquid in the reaction mixture of at least about 50 percent by weight of the weight of protein contained in the raw material.

27. The apparatus of any of claims 1-25, wherein the apparatus is capable of producing a yield of water-soluble protein from the liquid in the reaction mixture of at least about 60 percent by weight of the weight of protein contained in the raw material.

28. The apparatus of any of claims 1-25, wherein the apparatus is capable of producing a yield of water-soluble protein from the liquid in the reaction mixture of at least about 70 percent by weight of the weight of protein contained in the raw material.

29. The apparatus of any of claims 1-25, wherein the apparatus is capable of producing a yield of water-soluble protein from the liquid in the reaction mixture of about 70 percent by weight of the weight of protein contained in the raw material.

30. A method for the hydrolysis of protein-containing raw material comprising using the apparatus of any of claims 1-29 to hydrolyze said raw material.

31. A method for the hydrolysis of protein-containing raw material, the method comprising:

hydrolyzing, in a hydrolysis area, a reaction mixture comprising the raw material and an enzyme capable of hydrolyzing the protein in said raw material, wherein the reaction mixture contains both solids and liquid, and wherein upon hydrolysis the reaction mixture further comprises hydrolysis product;

inactivating, in an inactivation area, enzyme contained in the reaction mixture; and

separating at least a portion of the reaction mixture into two or more components, including at least one substantially liquid component which comprises water soluble protein.

32. The method of claim 31, wherein the step of separating comprises separating the at least a portion of the reaction mixture into at least one substantially liquid component and at least one substantially solid-containing component.

33. The method of claims 31 or 32, wherein any emulsion present in said method is maintained at an amount at or below a predetermined level.

34. The method of claim 33, wherein the level of emulsion present is maintained at or below about 5 %.

35. The method of claim 33, wherein the level of emulsion present is maintained at or below about 2 %.

36. The method of claim 33, wherein the level of emulsion present is maintained at or below about 1 %.

37. The method of claim 34, wherein the level of emulsion present is maintained at or below about 0.5 %.

38. The method of any of claims 31 to 37, wherein the step of separating comprises separating the at least a portion of the reaction mixture using a slanted filter screen to yield at least one substantially liquid component and a substantially solid component.

39. The method of any of claims 31 to 38, wherein the slanted filter screen has a mesh size of between about 1 and about 200 mesh.

40. The method of any of claims 31 to 39, wherein the separating step further comprises separating the at least one substantially liquid component into at least a first fraction comprising a water-soluble protein and at least a second fraction comprising a water-insoluble protein.

41. The method of claim 40, wherein the step of separating the at least one substantially liquid component comprises centrifugation.

42. The method of any of claims 31-41, wherein the reaction mixture is separated into a first component comprising primarily an aqueous solution, a second component comprising primarily lipids, and a third component comprising primarily solid matter.

43. The method of any of claims 31-42, wherein the step of separating comprises pumping the reaction mixture out of the inactivation reactor.

44. The method of any of claims 31-43, wherein the step of hydrolyzing comprises conveying the reaction mixture through the hydrolysis area with at least one feeder screw.

45. The method of any of claims 31-44, wherein the step of hydrolyzing comprises hydrolyzing the reaction mixture in a tube-shaped reactor.

46. The method of any of claims 31-45, wherein the step of inactivating comprises conveying the reaction mixture through the inactivation area with at least one feeder screw.

47. The method of any of claims 43-46, wherein at least one of the feeder screws rotates clockwise and counter-clockwise at different times during the inactivation step.

48. The method of any of claims 31-47, further comprising the step of pumping oil present in the reaction mixture away from the reaction mixture, or the step of decanting oil present in the reaction mixture, or both.

49. The method of claim 48, wherein oil is pumped away from the hydrolysis area, the inactivation area, or both.

50. The method of any of claims 31-49, wherein prior to the step of separating, the reaction mixture in the inactivation area is agitated to substantially suspend solid matter present in the inactivation area.

51. The method of any of claims 31-50, wherein prior to the step of hydrolyzing, the protein-containing raw material is collected in pieces in a collection area.

52. The method of claim 51, wherein, prior to hydrolysis, the collected pieces of raw material are processed to reduce the size of the pieces.

53. The method of claim 52, wherein the size of the pieces is from about 15 mm to about 50 mm.

54. The method of claim 52, wherein the size of the pieces is 300 mm or more.

55. The method of any of claims 31-54, wherein the raw material comprises material derived from the group consisting of fish, animal and plant material.

56. The method of claim 55, wherein the raw material comprises material derived from fish.

57. The method of any of claims 31-56, wherein the raw material is hydrolyzed at a rate of two tons per hour.

58. The method of any of claims 31-57, wherein the step of hydrolyzing is carried out as a continuous non-batch process.

59. The method of any of claims 31-58, wherein the step of inactivating is carried out as a continuous non-batch process.

60. The method of claim 58 or 59, wherein the continuous non-batch process is capable of continuous hydrolysis for at least seventy-two hours.

61. The method of any of claims 31-60, wherein the liquid in the reaction mixture is substantially separated from the solids and water soluble protein is obtained from the liquid.

62. The method of claim 61, wherein the yield of water soluble protein obtained from the method is at least about 50 percent by weight of the weight of protein contained in the raw material.

63. The method of claim 61, wherein the yield of water soluble protein obtained from the method is at least about 60 percent by weight of the weight of protein contained in the raw material.

64. The method of claim 61, wherein the yield of water soluble protein obtained from the method is at least about 70 percent by weight of the weight of protein contained in the raw material.

65. The method of claim 61, wherein the yield of water soluble protein obtained from the method is about 70 percent by weight of the weight of protein contained in the raw material.

66. A product containing water soluble protein obtained from the methods of any of claims 61-65.

67. A product according to claim 66, wherein the raw material comprises fish material, and wherein the product is soluble in water at room temperature, is substantially lipid free, and comprises one or more amino acids derived from fish.

68. The product of claim 66, wherein the one or more amino acids derived from fish comprise lysine and methionine.

69. The product of any of claims 67 or 68, wherein the product is substantially free of asparagine or glutamine.

70. The product of any of claims 67-69, wherein the product comprises taurine.

71. The product of any of claims 66-70, wherein the biological digestibility of the product is at least 70%.

72. The product of any of claims 66-70, wherein the biological digestibility of the product is at least 80%.

73. The product of any of claims 66-70, wherein the biological digestibility of the product is at least 90%.

74. An apparatus for the hydrolysis of protein-containing raw material, said raw material also containing solid matter, the apparatus comprising:

means for hydrolyzing said raw material by reacting a reaction mixture comprising said raw material and at least one enzyme present in said area, wherein the reaction mixture contains both solids and liquid, and wherein upon hydrolysis, said reaction mixture further comprises hydrolysis product;

means for substantially inactivating the enzyme present in the reaction mixture; and

means for separating at least a portion of the reaction mixture into two or more components, including at least one substantially liquid component which comprises water-soluble protein;

wherein said apparatus maintains any emulsion present in the liquid in the reaction mixture below a predetermined level.

75. A plant for the continuous hydrolysis of a reaction mixture of a protein containing animal or vegetable raw material, preferably a raw material in the form of by products or waste products from the processing of foodstuffs, into at least a liquid phase (13) and at least a solid phase (12) where the plant comprises a preparation section (1) a hydrolysis section (4) connected thereto, an inactivation section (7) connected to the hydrolysis section (4) and a final processing section (17) connected to the inactivation section, where the hydrolysis section (4) is of the type which comprises at least one substantially tube-shaped hydrolysis reactor (6) having a first feeder screw (20) for conveying

a reaction mixture of enzyme and raw material through the at least one tube-shaped hydrolysis reactor (6) and onward into the inactivation section (7) which has at least one inactivation reactor (8) connected to the hydrolysis section (4) with an inlet end (9) and an exit end (10) positioned opposite to it, characterized by the exit end (10) of the at least one inactivation reactor (8) having at last one outlet (14) for the solid phase (12) and at least one outlet (16) for the liquid phase (13) positioned at a distance from the outlet (14) for the solid phase (12).

76. A plant according to claim 75, characterized by the inactivation reactor (8) having a second feeder screw (24) for shifting the content of the inactivation reactor (8) onward towards the outlets (14, 16).

77. A plant according to claims 75 or 76, characterized by the inactivation reactor (8) having a third feeder screw (25) arranged at its bottom for shifting the sedimented solid matter onward and out through the outlet (14) for the solid phase (12).

78. A plant according to claims 75 or 76, characterized by at least one of the feeder screws (20,24,25) being of the type, which is arranged for rotating clockwise in a determined first period of time, and anti-clockwise in a determined second period of time.

79. A plant according to any of the claims 75-78, characterized by at least one of the feeder screws (20,24,25) being designed with scoops or sheets (22) in an area at the periphery of the threads (22) of the feeder screws (20,24,25).

80. A plant according to any of the claims 75-79 characterized by the outlets (16) for the liquid phase (14) comprising a fat outlet for a fatty fraction and at least one protein outlet for an aqueous fraction which contains ingredients selected from the group of water soluble amino acids, peptides and/or proteins, water-insoluble or heavily dissolvable amino acids, peptides and/or protein, or mixtures of these ingredients.

81. A plant according to any of the claims 75-78, characterized by the fact that at the outlet (16) for the liquid phase (14), means (18) are arranged for the purpose of mixing an aqueous phase, comprising dissolved and non-dissolved ingredients of protein origin, with the fatty phase.

82. A plant according to claim 81 characterized by the means for mixing the aqueous phase with the fatty phase being a blender impeller (18) or a circulation pump.

83. A plant according to claim 81 characterized by the fact that water soluble and water insoluble ingredients of protein origin and the fatty fraction are separated from each other in a continuously operating decanter or tricanter.

84. A method for continuously hydrolyzing a reaction mixture of a protein containing animal or vegetable raw material into a liquid phase (13) and a solid phase (12) in a plant according to claims 54 to 62, comprising the steps of:

dividing up the raw material;

admixing the raw material with enzyme;

enzymatically hydrolyzing the raw material in a determined period of time;

inactivating enzymes which are present in the reaction mixture, in an inactivation reactor (8), continuously letting out the solid phase (12) and the liquid phase (14) from the reaction mixture in the inactivation reactor (8), characterized by the liquid phase (13) comprising a fatty fraction and an aqueous fraction with a content of dissolved and non-dissolved ingredients of protein origin, the fatty fraction and the aqueous fraction being let out from the inactivation reactor (8) continuously either separately at identical or different rates or as a collective homogenized suspension.

85. A method according to claim 84, characterized by the dissolved and non-dissolved ingredients of protein origin and the fatty phase subsequently being separated in a tricanter or a decanter.

86. A method according to claims 84 or 85, characterized by the method comprising an introductory step in which metal parts are separated out from the raw material.

87. Protein hydrolysate manufactured by the plant according to claims 75-83 and/or the method according to claims 84-86.

88. Application of a protein hydrolysate according to claim 87 directly or after additional processing as nutrition or a nutritional supplement for humans or animals.

89. A plant and a method for continuous hydrolysis of a protein containing animal or vegetable raw material and application of the resulting hydrolysis products.